1.0 INTRODUCTION

This report presents the results of the remedial investigation (RI) for the Portland Harbor Superfund Site (Site) conducted by the Lower Willamette Group (LWG). Portland Harbor encompasses the downstream portion of the lower Willamette River and has served as the city of Portland's major industrial corridor since the mid 1800s[1]. The study area for the RI extends from river mile (RM) 1.9 [upriver end of the Port of Portland's Terminal 5] to RM 11.8 [near the Broadway Bridge], and data collection for the RI report extends from RM 0.8 to 26.4 [above Willamette Falls near Oregon City] (Map 1.0-1).

Portland Harbor was evaluated and proposed for inclusion on the National Priorities List (NPL) pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund), 42 U.S.C. §9605, by the U.S. Environmental Protection Agency (USEPA) and formally listed as a Superfund site in December 2000.

This RI report evaluates the environmental data collected and compiled by the LWG since the inception of the Portland Harbor Remedial Investigation and Feasibility Study (RI/FS) in 2001[2]. The LWG is performing the RI/FS for the Portland Harbor Superfund Site pursuant to a USEPA Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (AOC; USEPA 2001a, 2003b, 2006a). Oversight of the Portland Harbor RI/FS is being provided by USEPA with support from the Oregon Department of Environmental Quality (DEQ). EPA has entered into a Memorandum of Understanding (MOU) with DEQ, six federally recognized tribes, two other federal agencies, and one other state agency[3], who have all participated in providing support in the development of this document.

The content and organization of this RI report adhere to CERCLA's *Guidance Document for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (USEPA 1988). In accordance with these requirements, this report assembles data collected by the LWG and others, characterizes the physical characteristics and nature and extent of contamination in the study area based on those data, identifies sources of contaminants to the study area, provides an analysis of the fate and transport of contaminants, discusses background contaminant concentrations,

[1] In this RI report, the term "Portland Harbor" means the portion of the Willamette River containing the federal navigation channel, from RM 0 to 11.6. The term "lower Willamette River" means the portion of the Willamette River from its confluence with the Columbia River to Willamette Falls, or RM 0 to approximately RM 26.5.

[2] Upland source control efforts, including site-specific upland source control studies and implementation of source control measures, are performed under the oversight of DEQ and are not within the scope of the AOC and statement of work (SOW) for the in-water portion of the Site.

[3] Government parties that signed the MOU include: the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe, the National Oceanic and Atmospheric Administration, the U.S. Department of the Interior, and the Oregon Department of Fish and Wildlife.

presents the baseline human health risk assessment (BHHRA) and baseline ecological risk assessment (BERA), and provides a revised conceptual site model (CSM). Information collected during the RI will be used to help identify areas requiring cleanup. The feasibility study (FS) report will analyze and compare alternatives or approaches to remediate those areas that need cleanup to reduce or eliminate risks.

1.1 SITE BACKGROUND

1.1.1 Site Description

The Willamette River originates within Oregon in the Cascade Mountain Range and flows approximately 187 miles north to its confluence with the Columbia River. The lower reach of the Willamette River from RM 0 to approximately RM 26.5 is a wide, shallow, slow moving segment that is tidally influenced with tidal reversals occurring during low flow periods as far upstream as RM 15. The river segment between RM 3 and 10 is the primary depositional area of the Willamette River system. The lower reach has been extensively dredged to maintain a 40-ft deep navigation channel from RM 0 to 11.6. This segment of the lower reach includes a highly industrialized area known as Portland Harbor, which contains a multitude of facilities and both non-municipal and municipal outfalls.

Portland Harbor is located along an 11.6-mile dredged reach of the lower Willamette River in Portland, Oregon (Map 1.0-1). While the harbor area is heavily industrialized, it occurs within a region characterized by commercial, residential, recreational, and agricultural uses. Land use along the lower Willamette River in the harbor includes marine terminals, manufacturing, and other commercial operations, as well as public facilities, parks, and open spaces. Information regarding land use zoning within the lower Willamette River, as well as waterfront land ownership, is provided in Section 3 of this report.

1.1.2 Site History

The Willamette River is the 19th largest river in the United States and is one of 14 American Heritage Rivers in the country. During its 309-mile course, which ends by emptying into the Columbia River, it drains 11.7 percent of the state of Oregon.

In 1891, the Oregon State Legislature created the Port of Portland. By 1930, following a period of railroad and riverfront development, shipping tonnage for the Port increased to 4.1 million tons. The Port of Portland is now the largest wheat exporting port in the country (Port of Portland 2011). Cargo from more than 40 U.S. states passes through Portland as part of the approximately $15 billion in goods that travel the Columbia River system. As Oregon's major port and population center, the lower Willamette River sees a great variety of uses. For example, shipping, industrial, fishing, recreational, natural resource, and other interest groups all use the lower Willamette River.

Since the late 1800s, the Portland Harbor section of the lower Willamette River has been extensively modified to accommodate a vigorous shipping industry. Modifications include redirection and channelization of the main river, draining seasonal and permanent wetlands in the lower floodplain, and relatively frequent dredging to maintain the navigation channel. Constructed structures, such as wharfs, piers, floating docks, and pilings, are especially common in Portland Harbor where urbanization and industrialization are most prevalent. These structures are built largely to accommodate or support shipping traffic within the river and to stabilize the riverbanks for urban development. Riprap is the most common bank-stabilization measure. However, upland bulkheads and rubble piles are also used to stabilize the banks. Seawalls are used to control periodic flooding as most of the original wetlands bordering the Willamette in the Portland Harbor area have been filled. Detailed aerial photographs showing constructed structures are provided in Section 3 of this report

Today, the Willamette River is noticeably different from the river prior to industrial development that commenced in the mid to late 18th century. Historically, the Willamette was wider, had more sand bars and shoals, and fluctuated greatly in volume. In contrast, the main river now has been redirected and channelized, several lakes and wetlands in the lower floodplain have been filled and agricultural lands converted to urban or industrial areas. The end result is a river that is deeper and narrower than it was historically with higher banks that prevent the river from expanding during high-flow events. Further, the installation of a series of dams moderates fluctuations of flow in the lower Willamette River. Little, if any, original shoreline or river bottom exists that has not been modified by the above actions, or as a result of them. Some riverbank areas and adjacent parcels have been abandoned and allowed to revegetate, and beaches have formed along some modified shorelines due to relatively natural processes.

Numerous municipal and non-municipal outfalls, including storm drains and combined sewer overflows (CSOs), are located along both shores of the lower Willamette River in the metropolitan area. In the early 1900s, rivers in the United States were generally used as open sewers, which was also true for the Willamette (Carter 2006). The growing city's untreated sewage, as well as process water from a variety of industries, including slaughterhouses, chemical plants, electroplaters, paper mills, and food processors, was discharged directly into the river. The long history of industrial and shipping activities in the Portland Harbor, as well as agricultural, industrial, and municipal activities upstream of Portland Harbor, has contributed to chemical contamination of surface water and sediments in the lower Willamette River. Potential sources of chemical releases to the river are described in Section 4 of this report.

Development of the river has resulted in major modifications to the ecological function of the lower Willamette River. However, a number of species of invertebrates, fishes, birds, amphibians, and mammals, including some protected by the Endangered Species Act (ESA), use habitats that occur within and along the river. The river is also an important pathway for migration of anadromous fishes, such as salmon and lamprey. Various recreational fisheries, including salmon, bass, sturgeon, crayfish, and others,

use the lower Willamette River. A detailed description of ecological communities in Portland Harbor is presented in the BERA discussion in Section 9 and Appendix G of this report.

1.1.3 Navigational Channel Authorization History

A federal navigation channel, with an authorized depth of -40 ft, extends from the confluence of the lower Willamette River with the Columbia River to RM 11.6. Container and other commercial vessels regularly transit the river. Certain parts of the river require periodic maintenance dredging to keep the navigation channel at its authorized depth. In addition, the Port of Portland and other private entities periodically perform maintenance dredging to support access to dock and wharf facilities. Dredging activity has greatly altered the physical and ecological environment of the river in Portland Harbor.

The lower Willamette federal navigation project was first authorized in 1878 to deepen and maintain parts of the Columbia River and lower Willamette with a 20-ft minimum depth. The channel for both rivers has been deepened at various intervals since that time. The navigation depth for both rivers was increased to 25 ft in 1899 and to 30 ft in 1912. Between 1930 and 1935, the navigation channel depth was again increased to 35 ft, and in 1962 the authorized depth was increased to 40 ft. The current project authorization, as modified by Congress in 1962, encompasses 11.6 miles of the Willamette River below Portland and 103.5 miles of the Columbia River below Vancouver, Washington. Work on the authorized 40-ft-deep channel from Portland and Vancouver to the Pacific was completed in 1976. The Willamette River channel, from the Broadway Bridge (RM 11.6) to the mouth (RM 0), varies in width from 600 to 1,900 ft.

1.1.4 Previous Investigations

There have been numerous investigations of the Portland Harbor site dating back to the 1920s; however, most studies have been conducted from the late 1970s through the 1990s. Some investigations have been conducted on a larger scale (e.g., several river miles) while others have been conducted on a smaller scale (e.g., less than one river mile). Larger scale investigations have typically been conducted by or for federal or state agencies, such as the U.S. Army Corps of Engineers (USACE), the U.S. Geological Survey (USGS), the Oregon Department of State Lands (DSL), the Oregon Department of Fish and Wildlife (ODFW), the DEQ Water Program, and USEPA, to assess the health of the river system. Smaller scale investigations have typically been conducted by private parties for the purposes of maintenance dredging, construction and maintenance of in-river structures, or assessment of fate and transport of contamination from upland or in-water releases.

Nearly 700 documents and data sets were obtained that address conditions in the lower Willamette River. This information was used to develop an initial understanding of the

physical, chemical, and biological processes at the site and to assist in the development of the CSM for the study srea. Appendix A discusses which of these data sets were included in the final RI report.

1.2 REPORT ORGANIZATION

This document is organized as follows:

- **Section 1. Introduction.** This section describes the purpose of the report and presents site background information.
- **Section 2. Study Area Investigation.** This section presents summaries of the field activities associated with site characterization, the process used to assess data quality, and removal actions already completed.
- **Section 3. Environmental Setting.** This section discusses the results of activities to determine physical characteristics and human use of the study area.
- **Section 4. Identification of Sources.** This section describes the types of known and potential contaminant sources that affect the study area.
- **Section 5. In-River Distribution of Contamination.** This section presents the results of site characterization of contamination in various media within the Willamette River.
- **Section 6. Loading, Fate, and Transport for Select Contaminants.** This section presents an overview of the primary known sources of contaminants to the river, describes the processes affecting the release, transport, and fate of contaminants within the study area, and presents estimates of current pathway-specific mass-loading rates. Historical contributions to the study area are discussed qualitatively in this section.
- **Section 7. Determination of Background Concentrations for Indicator Contaminants.** This section provides an evaluation of the concentrations and distributions of contaminants in sediment samples collected from upstream reference locations (i.e., background) for use in development of remedial alternatives in the FS. .
- **Section 8. Baseline Human Health Risk Assessment Summary.** This section provides a summary of the BHHRA conducted for this site. The BHHRA is provided in Appendix F of this document.
- **Section 9. Baseline Ecological Risk Assessment Summary.** This section provides a summary of the BERA conducted for this site. The BERA is provided in Appendix G of this document.
- **Section 10. RI Conceptual Site Model Summary.** This section presents a study area-wide overview of the physical setting; contaminant distribution in sediments; contamination sources identified to date; external loading and

internal fate and transport mechanisms; and human health and ecological receptors, and exposure pathways and scenarios. For selected contaminants, this section also presents integrated, chemical-specific evaluations of nature and extent in abiotic and biotic media in the study area, and the relationships between the observed distribution in the system and known or likely historical and current sources of contamination.

- **Section 11. References.** Citations noted in the RI are found in this section.

- **Section 12. Glossary.** This section contains definitions of technical terms found in the RI.

Nine appendices are included with this document:

- **Appendix A. Data Sources and Site Characterization/Risk Assessment Database.** This appendix briefly summarizes the studies from which data in this RI report were obtained and includes the complete database in Access® files on compact disc. Data rules for the site characterization and risk assessment (SCRA) database for the RI data set and the BHHRA and BERA data sets are provided. Further, this appendix includes the process for calculating chemical concentrations from whole-body bass and carp samples.
- **Appendix B. DEQ September 2010 Milestone Report Table 1.** This appendix presents Table 1 from DEQ's Joint Source Control Strategy (JSCS) Milestone Report (DEQ 2010a).
- **Appendix C. Stormwater Statistics and Groundwater Characterization.** Summary statistics for stormwater collected by the LWG and other parties are included in this appendix. Details of the LWG's groundwater pathway assessment work, including identification of potential upland groundwater source areas and transition zone water (TZW) investigation results, are also provided.
- **Appendix D. In-River Distribution of Contaminants in Biotic and Abiotic Media.** Summary statistics of the chemical and physical data for all media are provided. The appendix includes constituent concentrations used in each summed analyte group for all media. Scatter plots, histograms, and maps of distribution of contaminants not included in the main report are also included in this appendix. A technical memo, *Comparison and Use of PCB Aroclor and Congener Data*, is included in this appendix.
- **Appendix E. Loading, Fate, and Transport Supporting Information and Calculations.** This appendix provides the analyses used to develop loading estimates for upstream surface water, stormwater, permitted point source discharges, atmospheric deposition, groundwater plumes, and advection through sediments.

- **Appendix F. Baseline Human Health Risk Assessment.** This appendix provides the final BHHRA conducted for this site.
- **Appendix G. Baseline Ecological Risk Assessment.** This appendix provides the final BERA conducted for this site.
- **Appendix H. Background Supporting Information.** This appendix contains the sediment background data set, information supporting the background calculations, and background statistics for contaminants not included in Section 7.
- **Appendix I. Interactive Map Application of Section 10 Panels.** This appendix provides an interactive map application of the three-section panel analyte-specific series included in Section 10 that present cross-media contaminant distributions and available source information for each of the 13 CSM contaminants. The panels show the entire study area, upland site property boundaries, outfall locations, historical industries, and river mile markers, and these layers can be turned on and off to display different combinations of information (e.g., subsurface sediment and biota polychlorinated biphenyl [PCB] distributions).